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Detonation propagation through methane-air mixtures with fuel concentration gradients DAVID KESSLER, VADIM GAMEZO, ELAINE ORAN, Naval Research Laboratory — The complex structure of a multidimensional detonation front consists of constantly changing, multiply intersecting incident shocks and Mach stems followed by growing and shrinking regions of reacted and unreacted gases. Because these flow structures change in time, the energy release in the shocked and compressed gases varies in space and time. Trajectories of triple points formed at shock intersections create cellular patterns whose size and structure are characteristic of the particular material and the background condition. In high-activation-energy fuel-air mixtures, such as methane in air, cellular patterns are relatively large, very irregular, and have complex and changing substructures. Here we use numerical simulations to study the behavior of detonations propagating through methane-air mixtures with a spatial gradient of fuel concentration. When the mixture stoichiometry varies from stoichiometric, the detonation propagation speed slows and sizes of cellular structures grow. In partially premixed systems with a nonuniform concentration of fuel – a condition that can occur, for example, naturally in sealed underground coal mine tunnels – both the propagation speed and the characteristic detonation cell size vary spatially.

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